Tomographic Site Characterization Using CPT, ERT and GPR

Developer: Applied Research Associates
Contract Number: DE-AR21-96MC33077
Crosscutting Area: CMST

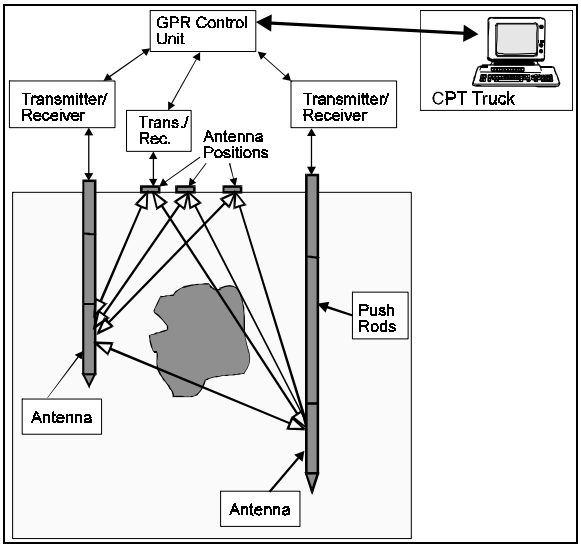
Subsurface Contaminants FOCUS AREA

Problem:

The Department of Energy is responsible for the clean up of inactive DOE sites and for bringing DOE sites and facilities into compliance with Federal, State, and local laws and regulations. DOE has identified a need for sensors, sensor deployment means, and sensor data processing, including sensor data-fusion methodologies for:

- Detection and monitoring of contaminates in soils, groundwater, and process effluents
- Expediting site characterization
- Geological and hydrogeological characterization and monitoring of the subsurface environment.

These techniques are required to better characterize the physical, hydrogeological, and chemical properties of the subsurface while minimizing and optimizing the use of boreholes and monitoring wells. Today the cone penetrometer technique (CPT) is demonstrating the value of a minimally invasive deployment system for site characterization.



Solution:

Develop a Ground Penetrating Radar (GPR) and Electrical Resistivity Tomographic (ERT) CPT cross-hole measurement system for tomographic imaging.

The project specifically addresses the DOE needs:

- Sensors: ERT and GPR tomography
- Sensor deployment: CPT techniques
- Sensor data processing: Tomographic Imaging
- Sensor data fusion: ERT and GPR

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Benefits:

- Delineating the continuity of soil layers between penetrometer holes
- Locating and mapping sand and clay lenses between penetrometer holes
- Mapping dense, non-aqueous phase liquids plumes
- Defining spatial and temporal behavior of a steam flood for dynamic stripping

- Detecting leaks under tanks at Hanford, WA

- Monitoring the efficiency of air sparging

- Monitoring an ohmic heating thermal front

- Characterization of burial trenches and pits, including boundaries and contents

- In situ measurement of physical properties, i. e., porosity, density and moisture content.

Technology:

The ERT technique uses quasi-dc methods where conduction currents are greater than displacement currents. For most soils, electrical resistivity ranges from 10 to 105 ohm meters and the dielectric constant, which is dictated by the water content, from 4 (dry) to 40 (saturated). In low resistivity conditions, the displacement current, or dielectric effect, is insignificant for frequencies less than 100 kHz. GPR methods, on the other hand, use frequencies from 10 to 1000 MHz where the response is controlled by water content as well a conductivity and where the depth of penetration is limited by attenuation due to low resistivity (high conductivity). Thus, ERT is more effective in low resistivity environments and GPR is more effective in high resistivity conditions. Combining the two methods, through an intelligent data fusion process, in a single site characterization survey will greatly enhance the available information about the subsurface conditions at the site.

Using the CPT for site characterization represents a new application of the technology. Significant advantages of the CPT include: eliminating drilling wastes and the need for treatment and disposal of drill spoils as hazardous material; providing continuous data on the subsurface stratigraphy in real time; identifying thin layers of significantly different hydraulic conductivity; eliminating the possibility of the crew being exposed to the potentially hazardous material; reducing the possibility of cross contamination (by grouting the hole as the probe is withdrawn), and is faster than conventional drilling and sampling.

Contacts:

The New England Division of Applied Research Associates, Inc. (ARA) has over 15 years of CPT experience. ARA is a nationally recognized expert in the design and use of advanced CPT equipment, especially in the area of geotechnical and environmental site characterization. For information on this project, the contractor contact is:

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DOE's Morgantown Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is:

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